

PROCESS OPTIMIZATION AND CHARACTERIZATION OF CEREAL BASED READY-TO-EAT EXTRUDED SNACK FOOD

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ABSTRACT

The cereal based Ready-To-Eat (RTE) snack, was prepared with blends of various flours including rice, corn, oats, barley and foxtail millet, using a twin screw extruder. Various trials were conducted with different proportions of raw materials. Based on sensory evaluation, the best proportion of ingredients used at the rate of 46% of rice flour, 36% of corn flour, 6% of oats, 6% of barley and 6% of foxtail millet was selected for further analysis. Physical parameters, chemical composition, textural characteristics, along with the sensory acceptability of the product were conducted. The physical parameters including length, diameter, bulk density and expansion ratio of the final product were 2.5cm, 1.9cm, 0.18g/cm³, 3.8, respectively. The proximate composition of prepared RTE snack contained 86.1% of carbohydrate, 11.2% of protein, 0.84% of fat, 1.18% of ash, 0.66 of % fiber, 6.3% of moisture content, 1.38% of calcium and 0.06% of phosphorus. The textural parameters hardness and fracture ability of the RTE snack are 551.58 gf and 6.52mm, respectively.

KEYWORDS: Ready-To-Eat (RTE), Twin Screw Extruder, Proximate Analysis & Sensory Analysis

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INTRODUCTION

The change in eating habits and the growing need of convenience foods, extruded snacks are popular amongst people of all ages. They can be consumed at anytime of the day (Khatijah *et al.*, 1997). Consumers want snacks, that taste good and smell good, feel good, look good and in addition, nutritionally superior and healthy (Priyankakocherla *et al.*, 2012). During the recent years, a number of technologies in food processing made an impact on the availability and variety of food products. Food extrusion is one of these latest multidimensional, food processing technique.

One major advantage of extrusion cooking, is the capability to produce a wide range of finished products, with minimum processing times, and by using inexpensive raw material (Riaz, 2000). Today, Extruders are used in a variety of applications, such as the manufacture of breakfast cereals, pasta, meat analogs, filled snack products, and pet food (Agbisit *et al.*, 2007). Cereals are the staple diet of most of the World's population. Cereal grains provide the world with the majority of its food calories, and about half of its protein. They are also a good source of micronutrients such as calcium, iron and vitamins of group B.

The aim of this study is to produce an RTE snack, with composite flours and study the effect of these

ingredients, on the physical parameters of extrudates and to evaluate the nutritional, textural characteristics, and to assess the sensory acceptability of the final product.

MATERIALS AND METHODS

Preparation of Materials for Extrusion

Ingredients such as rice, corn, oats, barley and foxtail millet, were procured from the local market. These ingredients were sun dried for 3-4 hours, to evaporate moisture. After drying, the ingredients were subjected to a proper milling process to obtain fine flour. The flours were sieved into fine powder. The flour from each ingredient was mixed in required proportion, which is described above. The moisture content was adjusted to 10% and the salt to about 1%. Simultaneously, pre-conditioned material was prepared. The prepared mixture was allowed to set for a few minutes.

Preconditioning

Preconditioning is the process of the blended samples, which are mixed thoroughly to get a homogenous mixture, and tempered by adding a predetermined amount of water, to adjust the feed moisture content to 17% – 20%.

Standardization of Formulation of Composite Flours

Various formulations of ingredients have been used, to standardize the final product composition.

Table 1: Different Formulations of Ingredients

S. No	Ingredients	Formula 1 (%)	Formula Trial 2 (%)	Trial 3 (%)	Trial 4 (%)
1.	Rice	30	35	46	42
2.	Corn	23	25	36	40
3.	Oats	12	9	6	7
4.	Barley	22	12	6	5
5.	Foxtail millet	13	9	6	4

Twin Screw Extruder

A laboratory model high shear counter-rotating, Twin-screw extruder processing machine (5-15 kg/hour) supplied by Basic technological private limited, Kolkata, was used for the development of extrudates. The preliminary trials were conducted, with different formulations at 105°C (heater I) and 60°C (heater II) temperature, 370 rpm screw speed, cutter speed 180 rpm and feeder speed 22rpm.

Preparation of RTE Snack

The pre-conditioned material was fed into the extruder, through the screw feeder. The pre-conditioned material which contained a maximum of 10% moisture, in the mixture was allowed to extrusion. Based on the results of preliminary study the ingredients, namely rice, corn, oats, barley and foxtail millet were mixed in a proportion of 46:36:6:6:6, respectively, and was selected to finalize the product formulation. The extrudates were placed in hot air oven, at 70°C to improve the crispiness of the product. After thorough mixing of puffs with oil, the masala powder was sprayed over the product, to enhance the taste of the product. The product was packed in the polyethylene packs and stored at ambient temperature.

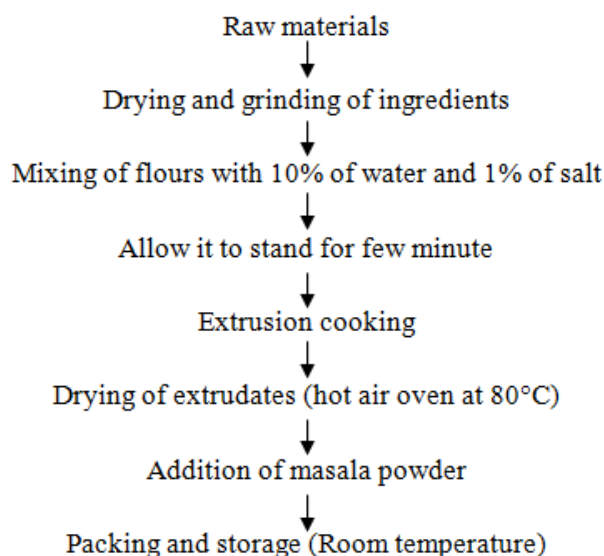


Figure 1: Flow Chart for Preparation of RTE Snack

Physical Parameter Analysis

Physical parameters i.e., diameter, length, expansion ratio and bulk density of the selected extrudates, were recorded. Length and diameter of the extrudates were measured using vernier caliper, in centimeters. The expansion ratio was calculated, based on the sectional diameter of the extrudate and the extruder die. It is expressed by average of diameter of 10 extrudates, divided by the diameter of the die used (Singh et al., 2000). Bulk density, accounts for the expansion of the product in all directions and is measured as mass of product, residing in a specified unit of volume. Ten 4 mm samples, from each extrusion run were weighed and divided by the volume of each sample, to calculate the bulk density.

Proximate Analysis of RTE Snack

The methods of the association of Official Analytical chemist (AOAC, 1990) were used for determination of moisture, ash, protein, carbohydrates, fat and fibre content, of the RTE snack. All the determinations were done in triplicates. 5g each in triplicates was used for determination of moisture content, by weighing in crucible and drying in oven at 105°C, until a constant weight was obtained. Determination of ash content was done by ashing at 550°C for about 3hr. The kjedhal method (AOAC, 1990) was used to determine the protein content by multiplication of the nitrogen value, with a conversion factor (6.25). The fat was done by a soxhlet extraction method.

Texture Analysis

Texture, is one of the most important quality features of extruded products. The texture of extruded foods is one of the key parameters, driving consumer preference. The extruded snacks represent new products, with unique textural attributes, that make them popular among consumers. 3 Point bends rig texture analysis, was used to analyze the hardness and fracturability of the extruded snack.

Sensory Analysis

These types of tester, supply information about people's likes and dislikes of a product. The extruded snack food sample was given to people for evaluation, of organoleptic characteristics viz, appearance, color, Taste, flavor, Texture and

Overall Acceptability. It was served to judge on the day of preparation.



Figure 2: RTE Snacks

RESULTS AND DISCUSSIONS

The RTE snack was prepared with various cereals, by using extrusion technique. In every trial, the product was allowed to sensory evaluation, to standardize the optimum product. Among the different formulations trial, 3 had good sensory characteristics. The products of trial 3 scored better score for all sensory attribute, as well as overall acceptability. These results were found to be similar to the ones of, Despande *et al.*, 2011. According to his work, the incorporation of coarse millet grains and pulses, mixed at the level of 70:30, respectively produce a better acceptable product. The similar trend was observed by Kocherla *et al.*, (2012) and she stated that, the products made by incorporating cheese powder at different levels, received higher scores for taste in comparison to the other experimental products.

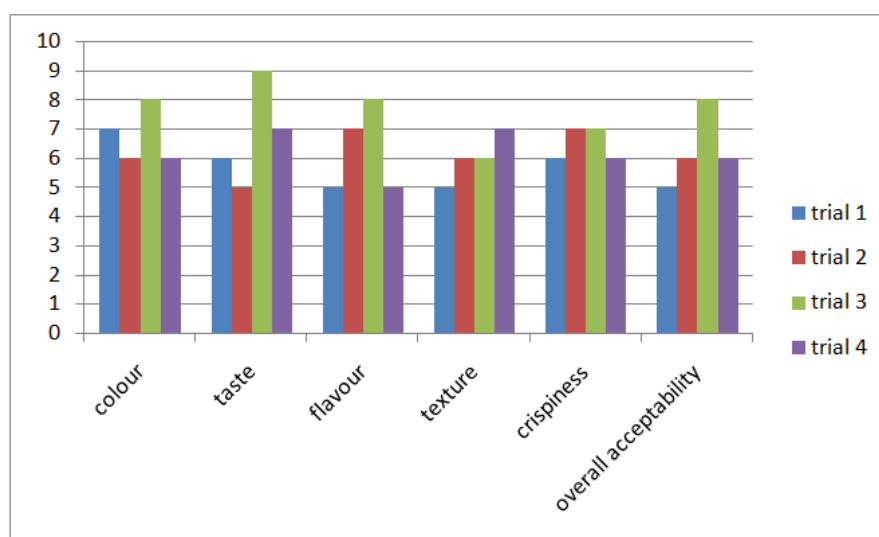


Figure 3: Sensory Result for Various Trials

Physical Properties of Extrudates

The measurements have taken as ten and the average values were tabulated. Table 2 showed the length (cm), Diameter (cm), Bulk density (g/cm^3), and Expansion ratio of the product, that were 2.5, 1.9, 0.187, and 3.8, respectively. The similar trend was observed by Kocherla *et al.*, 2012. She reported that, extruded products made by incorporating cheese powder at 15% and 20% level, the product with the 20 % incorporation showed highest diameter (14.4 mm) and expansion ratio. This could be, due to good puffing property of cheese. According to Maskus H, and Arntfield (2015), the

screw speed and feed moisture were found to have a significant effect on the expansion of the extrudate. In twin-screw extrusion, screw speed is known to have a diminutive effect on extrudate expansion. A high expansion ratio is desirable in a production of expanded snacks. As the temperature of extrusion cooking increased, starch becomes, more fully cooked and thus better able to expand.

Table 2: Physical properties and proximate composition

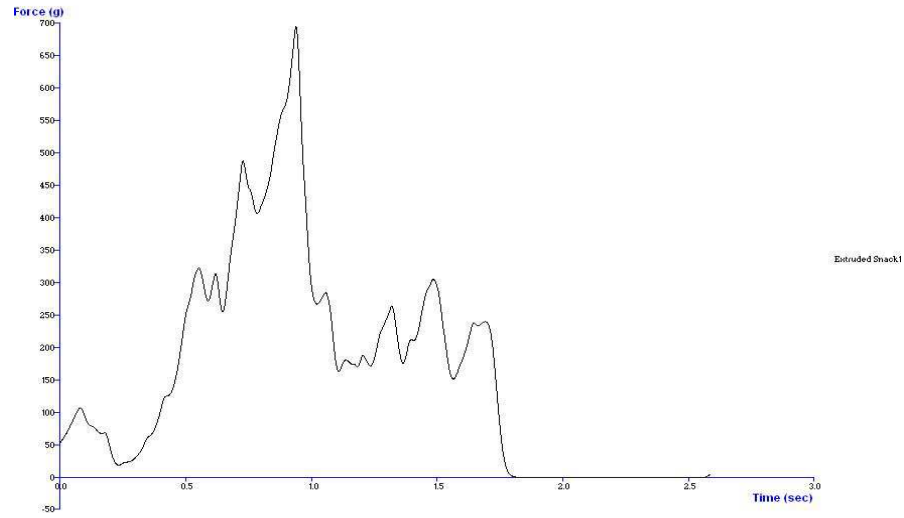
Physical Properties							
Length (cm)	Diameter (cm)		Bulk Density (g/cm ³)			Expansion Ratio	
2.5	1.9		0.187			3.8	
Proximate Composition							
Carbohydrate	Moisture	Protein	Fat	Ash	Calcium	Phosphorus	Crude Fibre
76.10	6.30	11.2	0.84	1.38	1.18	0.06	0.66
Texture analysis							
Hardness (gf)				Fracturability (mm)			
551.58				6.52			

Proximate Analysis

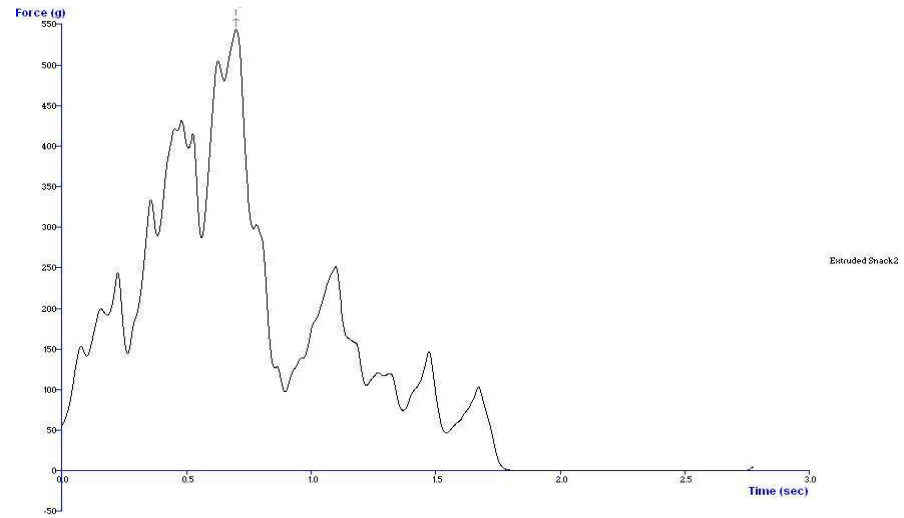
Table 2, showed the proximate analysis of snack food and it contained 76.10% of carbohydrate, 6.3% of moisture, 11.2 % of protein, 0.84% of fat, 1.38% of ash, 1.18% of Calcium, 0.06% of Phosphorus and 0.66% of Crude fibre. These findings were found to be similar to Kiran. J, et al. (2003), in extruded snack foods made with Kesari dhal (*Lathyrus sativus*) and chickpea flour and reported that, the fibre content ranged from 0.19 – 2.50 g. The RTE snack food was fairly rich in starch. This trend was found to be similar to the results of Manisha and Udhay.2013), and she opined that starch is the most influential component of flour, affecting the structural and functional properties of extrudates.

Texture Analysis of RTE Snack

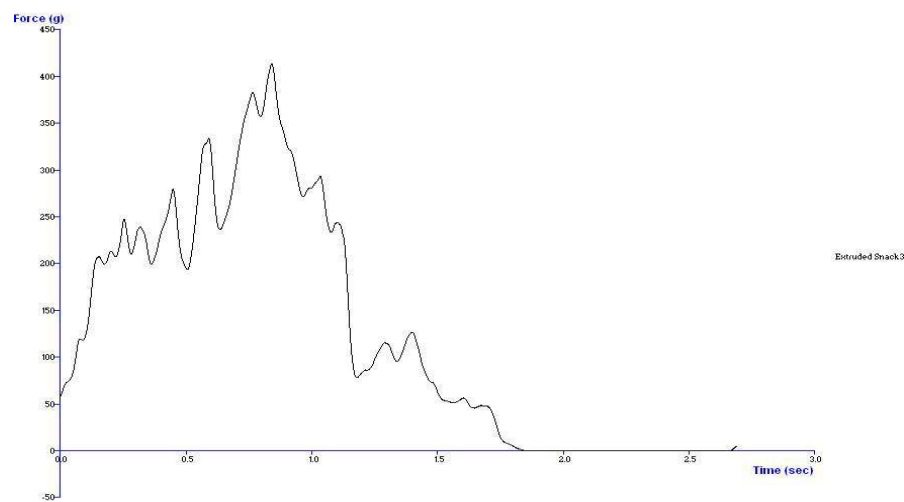
The texture analysis of RTE snacks showed that, 551.58gf of hardness and 6.52mm of fracturability. The texture was analyzed for three samples, among this the concordant value was taken. The texture analysis graphs were shown in the figure 5, figure 6 and figure 7. The similar study was conducted by Si-quan Li *et al.*, 2005. Further, he stated that the increase in the addition of soya bean flour in the mix, and increase in Screw speed significantly decreased the hardness of the extrudates. The increased value of RTE snack food might be, due to the reduced expansion caused by the increase in the content of moisture. Increasing the screw speed also resulted in a decrease, in the hardness. The increasing feed rate was found to have a less significant effect, on the hardness of the extrudate.



Graph 1: Texture Analysis Graph Extruded Snack 1



Graph 2: Texture Analysis Graph for Extruded Snack 2



Graph 3: Texture Analysis Graph for Extruded Snack 3

CONCLUSIONS

The RTE snack was prepared with various cereals, by using extrusion technique. The present study revealed that, the composite flours (rice: corn: oats: barley: foxtail: millet in the ratios of 46 : 36 : 6: 6: 6) could be used to produce a good quality extrudates, with acceptable sensory properties. The incorporation of various cereals and foxtail millet can be effectively used, to produce RTE extruded snacks, by extrusion cooking. These ingredients improved nutrient content of the product. It was an attempt to produce healthy snack, with the combination of these five ingredients.

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